Cross-Generational Contributors to Preterm Birth in California: Singletons Based on Race/Ethnicity

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Abstract

Objective Multiple studies have examined cross-generational patterns of preterm birth (PTB), yet results have been inconsistent and generally focused on primarily white populations. We examine the cross-generational PTB risk across racial/ethnic groups.

Study Design Retrospective study of 388,474 grandmother–mother–infant triads with infants drawn from birth registry of singleton live births between 2005 and 2011 in California. Using logistic regression (odds ratios [ORs] and confidence intervals [CIs]), we examined the risk of preterm delivery by gestational age, sociodemographic, socioeconomic, and obstetric clinical characteristics stratified by maternal race/ethnicity.

Results The risk of having a preterm infant <32 weeks was greater for women born at <32 weeks (OR: 2.09, 95% CI: 1.62–2.70) and 32 to 36 weeks (OR: 1.51, 95% CI: 1.35–1.70). This increased risk of preterm delivery was present among women in all race/ethnicity groups (white [AOR: 2.00, 95% CI: 1.52–2.63), black [AOR: 1.79, 95% CI: 1.37–2.34], Hispanic [AOR: 2.39, 95% CI: 2.05–2.79], and Asian [AOR: 2.12, 95% CI: 1.20–3.91]), with hypertension as the only consistent risk factor associated with increased risk of preterm delivery.

Conclusion Our findings suggest a cross-generational risk of PTB that is consistent across race/ethnicity with hypertension as the only consistent risk factor.

Keywords
- birth
- outcome
- gestational age
- preterm birth

Preterm birth (PTB), defined as birth prior to 37 completed weeks of gestation, is one of the leading causes of perinatal mortality and morbidity.[1] The U.S. PTB rate peaked in 2006 at 12.8% and steadily declined to a rate of 9.6% in 2014; yet, it still remains one of the highest among industrialized countries at an economic cost of 26 billion dollars per year.[1,2]

Although the exact causes of PTB are unknown, there are various proposed pathophysiologic processes[3–5] and interventions aimed at prevention.[6–9] A history of prior PTB has

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been shown to be one of the strongest known clinical risk factors for a subsequent PTB, increasing the risk by 1.5- to 2-fold.[10–12] Additionally, previous studies have identified multiple risk factors for PTB, including maternal sociodemographic and clinical factors, such as maternal black race, extreme of ages < 18 and >40 years, lower socioeconomic status, hypertension, diabetes, and anemia.[10,13–15] Further, there is some evidence that known sociodemographic and clinical risk factors for PTB are associated with preterm delivery across generations.[16–27]

Previous studies have examined cross-generational risk factors for PTB, that is, whether women who themselves were born preterm are at greater risk of having a PTB themselves. Three studies found an association between a mother being born preterm and having a preterm infant,[20,22,23,26] while two others did not find such an association.[28,29] These studies were largely based on white mothers, and have not provided data on cross-generational risk of PTB in women of other races and ethnicities and additionally have not been sufficiently powered to detect an association.[10–12,16–27] More recent studies focusing on maternal race as an independent risk factor for PTB across generation have demonstrated mixed results.[30] In one study, although cross-generational risk for PTB was demonstrated in non-Hispanic black women, it was not demonstrated in non-Hispanic white women.[31]

In this study, we examine cross-generational patterns of PTB in a large, diverse California cohort of women with extensive data available on their own births as well as their deliveries. The objectives of this study are (1) to evaluate cross-generational risk of PTB within and across maternal race/ethnicity and (2) to examine whether sociodemographic and obstetric clinical factors in the mother and grandmother are associated with cross-generational patterns of PTB.

Materials and Methods

Our sample was composed of 380,542 grandmother–mother–infant triads with infants drawn from a 7-year retrospective birth cohort of 3,767,337 singleton live births delivered from 2005 through 2011 in California. The index infants in the triads are the infants from the third or youngest generation. Sample selection proceeded by first identifying birth records of 757,273 mothers born in California and their singleton pregnancies delivered in California based on vital statistics birth certificate files, using linkage algorithms that leveraged identifiers and other data including mother's first, last, and maiden names, birth date, and birth place as listed on the infant's birth certificate and linked to infant's information listed on the mother's own birth certificate. Infants with known or suspected congenital anomalies ($N = 7{,}932$) were excluded. Participants were then linked to the U.S. Census zip code level data to retrieve neighborhood socioeconomic factors at mothers' and infants' births using birth year and maternal residential zip code reported in mothers' and infants' birth certificates.[32] Mothers born in the 1980s and the 1990s were linked to the decennial 1980 and 1990 Census data, respectively. Infants born in the 2000s (2005–2009) and the 2010s (2010–2011) were linked to the decennial 2000 and 2010 Census data, respectively. Subject triads were restricted to infants with hospital discharge records available through the California Office of Statewide Health Planning and Development to retrieve obstetric factors ($N = 438{,}580$). Subjects were excluded if either the mothers' or infants' gestational age at delivery was less than 20 completed weeks or more than 44 completed weeks, based on last menstrual period (for mothers and infants born before 2007) or "best obstetric estimate" (for infants born in 2007 or later) reported on the birth certificate. Subjects were further excluded if birth weight was 3 standard deviations below or above the mean, and thus an implausible birth weight for gestational age.[33]

The study outcome was preterm delivery (<37 completed gestational weeks) of infants further categorized into <32 and 32 to 36 weeks of gestation wherein mothers' own gestational age at birth (<32 and 32–36 vs. ≥ 37 or <37 vs. ≥ 37 weeks of gestation) was analyzed as a risk factor. To identify risk factors for PTB among mothers born preterm, we stratified the analysis by gestational age of mother's birth (<37 and ≥ 37 weeks) and race/ethnicity of mother (white non-Hispanic, Hispanic, black non-Hispanic, and Asian [henceforth white, Hispanic, black, and Asian] reported on infant's birth records), and then examined maternal sociodemographic, neighborhood socioeconomic, and obstetric clinical characteristics across generations. Initially, unadjusted odds ratios (ORs) and their 95% confidence intervals (CIs) derived from logistic regression were used to measure the relationship between each of the candidate risk factors and preterm status at infants' births with term birth as the reference. These covariates were chosen because of established association with PTB. We then conducted multiple logistic regression analysis including all risk factors (detailed later) to derive adjusted ORs (AORs) and 95% CIs. Separate logistic regression models were generated for each race/ethnicity group. Subjects with missing values of variables were excluded in the analytical step involving the specific variables.

Sociodemographic characteristics derived from both mothers' and infants' birth certificate data included maternal age, parity, and Medicaid coverage for the delivery. Neighborhood socioeconomic factors derived from the Census data (reported by decade) included $\geq$50% of population living below 200% poverty level and $\geq$50% of population over 25 years with less than high school degree in the maternal residential zip code reported in mother's or infant's birth certificate. Obstetric risk factors included maternal hypertension, diabetes, and anemia. Coding for hypertension (including pregnancy-induced hypertension and chronic hypertension), diabetes, and anemia during the grandmother's pregnancy was based on pregnancy complications reported in the mother's birth certificate. Coding for hypertension (including preexisting and gestational hypertension), diabetes (including preexisting and gestational diabetes), and anemia during mother's pregnancy was based on the International Classification of Disease, 9th Revision, Clinical Modification[21] four digit codes contained in the mother's hospital discharge files. Source of payment for infant delivery was dichotomized as Medi-Cal (California's

Medicaid) or not. All other aforementioned risk factors were recoded as presence in both grandmother's and mother's pregnancies, grandmother's or mother's pregnancy only, and neither pregnancy (the referent group).

All analyses were performed using Statistical Analysis Software (SAS) version 9.3 (Cary, NC) and were based on data received by the Genetic Disease Screening Program at the California Department of Public Health as of February 1, 2015. Methods and protocols for the study were approved by the Committee for the Protection of Human Subjects within the Health and Human Services Agency of the State of California.

Results

Among the 380,542 index infants of these infant–index mother–grandmother triad cohorts, 36,131 (9.5%) of the index mothers (henceforth referred to as "mothers") of the triads were born preterm. Distribution of infant's birth year in mothers born preterm was similar to that in the total population. Twenty per cent of these preterm mothers were identified as white, 14% black, 54% Hispanic, and 4% Asian. Demographics for the total sample and the subsample of mothers who were born preterm are presented in ►**Table 1**.

The risk of having a preterm infant <32 weeks of gestation was greater for women born at <32 weeks (OR: 2.09, 95% CI: 1.62–2.70) and 32 to 36 weeks (OR: 1.51, 95% CI: 1.35–1.70) compared with women born at 37 weeks or later. Similarly, the risk of a PTB at 32 to 36 weeks was greater for women born themselves at <32 weeks (OR: 1.31, 95% CI: 1.17–1.48) or 32 to 36 weeks (OR: 1.26, 95% CI: 1.21–1.32) compared with women born at 37 weeks or later (►**Table 2**).

We found an increased risk of preterm delivery for mothers born preterm versus term among black women (OR: 1.245, 95% CI: 1.12–1.38), Hispanic women (OR: 1.26, 95% CI: 1.20–1.33), white women (OR: 1.29, 95% CI: 1.17–1.42), and among Asian women (OR: 1.22, 95% CI: 1.02–1.46) (►**Table 3**).

Sociodemographic Factors and Risk of Preterm Delivery in Women Born Preterm

In unadjusted analysis, maternal age <18 years at delivery was associated with increased risk of a preterm delivery among Hispanic women born preterm; this was true when either the mother only or grandmother only was <18 years at delivery (OR: 1.24, 95% CI: 1.09–1.40) (►**Table 4**). Age <18 years at delivery was not associated with preterm delivery in the models for white, black, or Asian women.

Neighborhood-level adult educational attainment, poverty level, and Medi-Cal coverage for delivery were not significantly associated with preterm delivery among women born preterm.

Obstetrical Factors and Risk of Preterm Delivery

In unadjusted analysis, several group risks for PTB were observed. Across each race/ethnicity group, hypertension was strongly associated with increased risk of a PTB (►**Table 4**). For example, among white women born preterm, those with hypertension in either the mother only or grandmother only had an unadjusted OR of 2.11 (95% CI: 1.63–2.72). This increased risk of preterm delivery for mother/grandmother with hypertension was also true among black women (OR: 1.79, 95% CI: 1.39–2.31), Hispanic women (OR: 2.36, 95% CI: 2.03–2.73), and Asian women (OR: 2.18, 95% CI: 1.25–3.80) born preterm. Anemia and nulliparity were not consistently associated with preterm delivery; however, diabetes (in either mother only or grandmother only) was associated with increased odds of a preterm delivery among white (OR: 1.845, 95% CI: 1.24–2.72) and Hispanic (OR: 1.34, 95% CI: 1.05–1.70) mothers born preterm, when compared with their preterm-born counterparts without diabetes in either pregnancy. Diabetes in either the mother only or grandmother only among black and Asian preterm women was not significantly associated with PTB.

Many of the significant findings did not retain statistical significance in adjusted analyses (►**Table 5**). In analyses adjusted by maternal sociodemographic, neighborhood socioeconomic, and obstetric clinical characteristics, hypertension (in mother's or grandmother's pregnancy only) continued to be associated with increased risk of preterm delivery among white (AOR: 2.00, 95% CI: 1.52–2.63), black (AOR: 1.79, 95% CI: 1.37–2.34), Hispanic (AOR: 2.39, 95% CI: 2.05–2.79), and Asian (AOR: 2.17, 95% CI: 1.20–3.91) women born preterm. Maternal age <18 years at delivery and diabetes were also associated with increased risk of a preterm delivery in adjusted models among Hispanic women only—a pattern that was consistent with the unadjusted ORs (►**Tables 4** and **5**).

Comment

We found that women born preterm were more likely to have a PTB compared with their counterparts born at term; this increased odds of preterm delivery was greatest for delivery <32 weeks of gestation. While several within race/ethnicity group risks for PTB were observed (e.g., maternal age <18 years in the mother or grandmother Hispanic women, diabetes in the mother or grandmother in White and Hispanic women), only hypertension (in the mother or grandmother) was found to be associated with PTB across all groups.

Our findings are consistent with previous studies that have demonstrated an intergenerational risk for PTB. Porter et al utilized birth registries from Utah to demonstrate an increased risk of preterm delivery for white mothers who were born preterm, compared with white mothers born at term. This increased risk for PTB increased further with decreasing infant gestational age at delivery, with greater than twice the odds of PTB when an infant was born before 30 weeks.[26] In a cohort of Scottish women, Bhattachary et al demonstrated that mothers who were born spontaneously preterm had 1.5 times the odds of a spontaneously PTB.[20] The current study adds to these previous findings by demonstrating increased risk of preterm delivery for mothers born preterm using a large, diverse population, wherein we had the ability to examine the contribution of sociodemographic

Table 1 Sample characteristics of infant

Mother and grandmother characteristics	Total	Mother born preterm
	N (%)	*N* (%)
Total	380,542 (100)	36,131 (100)
Infant birth year		
2005	36,576 (9.6)	3,598 (10.0)
2006	37,277 (9.8)	3,704 (10.2)
2007	50,975 (13.4)	4,895 (13.6)
2008	57,505 (15.1)	5,562 (15.4)
2009	61,185 (16.1)	5,776 (16.0)
2010	65,139 (17.1)	6,006 (16.6)
2011	71,885 (18.9)	6,590 (18.2)
Mother characteristics		
Race/ethnicity		
White	101,024 (26.6)	7,060 (19.6)
Black	30,271 (8.0)	4,951 (13.7)
Hispanic	206,770 (54.3)	19,575 (54.1)
Asian	12,481 (3.3)	1,542 (4.3)
American Indian or Alaska natives	2,790 (0.7)	298 (0.8)
Hawaiian or other Pacific Islander	1,770 (0.5)	244 (0.7)
Other/multiracial	20,707 (5.4)	2,037 (5.6)
Age at delivery (y)		
$<$ 18	40,784 (10.7)	4,093 (11.3)
$\geq$ 18	339,710 (89.3)	32,035 (88.7)
Zip code $\geq$50% of population over 25 years with less than high school degree	61,477 (16.2)	6,718 (18.6)
Hypertension	25,022 (6.6)	2,634 (7.3)
Anemia	32,354 (8.5)	3,245 (9.0)
Diabetes	12,688 (3.3)	1,278 (3.5)
Grandmother characteristics		
Race/ethnicity		
White	12,315 (31.9)	8,701 (24.1)
Black	30,974 (8.1)	5,090 (14.1)
Hispanic	207,021 (54.4)	19,837 (54.9)
Asian	15,210 (4.0)	1,821 (5.0)
American Indian or Alaska natives	2,769 (0.7)	281 (0.8)
Hawaiian or other Pacific Islander	1,663 (0.4)	249 (0.7)
Other	346 (0.1)	43 (0.1)
Age at delivery (y)		
$<$ 18	24,893 (6.5)	3,243 (9.0)
$\geq$ 18	355,545 (93.4)	32,877 (91.0)
Zip code $>=$ 50% of population over 25 years with less than high school degree	85,625 (22.5)	9,080 (25.1)
Hypertension	2,481 (0.7)	636 (1.8)
Anemia	1,115 (0.3)	272 (0.8)
Diabetes	1,288 (0.3)	139 (0.4)

Table 2 Odds of preterm delivery by gestational weeks of mother birth

Gestational weeks of infant birth	Gestational weeks of mother birth								
	<32			32–36			≥37		
	N	%	OR (95% CI)	*N*	%	OR (95% CI)	*N*	%	OR (95% CI)
Total	4,301			31,830			344,411		
<32	61	1.4	2.09 (1.62–2.70)[a]	329	1.0	1.51 (1.35–1.70)[a]	2,400	0.7	
32–36	306	7.1	1.31 (1.17–1.48)[a]	2,193	6.9	1.26 (1.21–1.32)[a]	19,134	5.5	
≥37	3,934	91.5	Reference	29,308	91.8	Reference	322,877	93.8	Reference

Abbreviations: CI, confidence interval; OR, odds ratio.
[a]$p < 0.0001$.

and obstetrical factors in both the mother and grandmother of the index infant.

We found that the risk of PTB in offspring when a mother is born preterm is consistent across race/ethnicity. For example, we found that the risk of a PTB for a mother born preterm was not significantly different among black versus white women. Recent data show that the rate of PTB is 13.30% for black mothers, compared with 8.91% for non-Hispanic white mothers.[2] Black race has consistently been shown to be an independent risk factor for PTB (conferring up to a twofold increase risk even after adjusting for confounding variables).[3,16,24,25,27] It is not clear to what extent the cross-generational risk of PTB is a contributor to the wide and persistent disparities of PTB in black versus white women; further investigation is needed to elucidate this question.

Women <18 and > 40 years have been shown to be at increased risk of PTB.[34,35] In our study, we observed that delivery before 18 years in either mother only, grandmother only, and both was associated with intergenerational preterm risk in Hispanic women only. This information may point to important within race/ethnicity differences contributing to cross-generation patterns. It is also likely that the smaller *N* for women in this category of delivery <18 years among white, black, and Asian women affected our ability to detect statistically significant differences across other race/ethnicities.

Hypertensive disorders of pregnancy complicate roughly 5 to 10% of pregnancies and are associated with increased risk across the subtypes.[36,37] Evidence for hereditary plausibility is demonstrated by women whose mothers had preeclampsia being more likely to have preeclampsia.[38] In a Swedish prospective cohort study, women who had preeclampsia in a previous pregnancy had a 15% chance of developing preeclampsia in a subsequent pregnancy.[39] Consistent with these previous studies, we found twice the odds for PTB when grandmother or mother were hypertensive, among mothers born preterm. We did not have sufficient numbers to examine the cross-generational risk of preexisting and gestational hypertension; future studies with a larger sample of triad cohorts will be necessary to understand the differences in cross-generational risk by hypertension type.

Many of the maternal sociodemographic, neighborhood socioeconomic, and clinical risk factors were associated with increased risk of preterm delivery consistently among women born at term. Among index mothers born preterm, we found fewer correlates of preterm delivery in their infants. As the number of preterm born mothers was small for many of the risk factors, we may not have had sufficient power to detect associations with statistical significance. Hypertension, anemia, and diabetes in both the mother and grandmother were not examined due to small sample size ($N < 5$).

Strengths of our study include the use of a large heterogeneous population with data abstracted from birth registries, thereby eliminating some recall bias. In addition, birth registries offered the opportunity of linkage through three generations.

There are, of course, multiple limitations as well. We cannot distinguish whether these PTBs were an outcome of spontaneous labor versus induction of labor. This is an important limitation as there may be a portion of the cross-generational preterm risk that could be attributed to induction due to obstetric risks. In addition, there may be regional variation in obstetric practices regarding iatrogenic delivery that may have impacted our results. Our PTB rate in our study period was lower than the national average, which may reflect inaccurate reporting or/and variation by state. Our analysis lacks diagnostic specificity around conditions such as diabetes and hypertension, as described earlier. For example, it is possible that some of our findings could be explained by familial hypertension risk. Another limitation to consider is that while there were factors that were statistically significant, the varying magnitude of the ORs should be taken into account when assessing clinical significance. Additionally, since we had multiple comparisons, the *p*-values merit attention. A conservative Bonferroni correction would require $p < 0.0002$ as significant; however, most of our findings met the more stringent *p*-value of < 0.0001. We relied on birth registry data and hospital discharge records, which may suffer from inaccuracies in gestational age, indicated versus unindicated deliveries, and classification of obstetrical complications. We were not able to otherwise confirm the accuracy of the birth registry data against any other sources. Additionally, the number of births in some groups analyzed (such as births <32 weeks, or preterm with diabetes) was small; however,

Table 3 Unadjusted and adjusted[a] OR and 95% CI of preterm delivery by gestational weeks of mother birth and mother's race/ethnicity

Gestational weeks of infant at birth	Mother's race/ethnicity							
	White		Black		Hispanic		Asian	
	Mother birth <37 wk	Mother birth ≥37 wk	Mother birth <37 wk	Mother birth ≥37 wk	Mother birth <37 wk	Mother birth ≥37 wk	Mother birth <37 wk	Mother birth ≥37 wk
	N (%) Unadjusted OR (95% CI) Adjusted[a] OR (95% CI)	*N* (%)	*N* (%) Unadjusted OR (95% CI) Adjusted[a] OR (95% CI)	*N* (%)	*N* (%) Unadjusted OR (95% CI) Adjusted[a] OR (95% CI)	*N* (%)	*N* (%) Unadjusted OR (95% CI) Adjusted[a] OR (95% CI)	*N* (%)
<37	462 (6.5)	4,854 (5.2)	488 (9.8)	2,051 (8.1)	1,550 (7.9)	11,972 (6.4)	154 (10.0)	903 (8.4)
	1.29 (1.17–1.42)[b]		1.24 (1.12–1.38)[b]		1.26 (1.20–1.33)[b]		1.22 (1.02–1.46)[c]	
	1.19 (1.07–1.32)[d]		1.17 (1.05–1.31)[d]		1.21 (1.14–1.28)[b]		1.19 (0.98–1.43)	
<32	64 (0.9)	476 (0.5)	91 (1.8)	327 (1.3)	180 (0.9)	1,265 (0.7)	27 (1.8)	96 (0.9)
	1.82 (1.40–2.36)[b]		1.45 (1.15–1.83)[d]		1.38 (1.18–1.62)[b]		2.03 (1.32–3.03)[d]	
	1.71 (1.30–2.24)[d]		1.37 (1.07–1.75)[c]		1.31 (1.11–1.55)[d]		2.02 (1.30–3.12)[d]	
32–36	398 (5.6)	4,378 (4.7)	397 (8.0)	1,724 (6.8)	1,370 (7.0)	10,707 (5.2)	127 (8.2)	817 (7.5)
	1.23 (1.11–1.37)[d]		1.20 (1.07–1.35)[d]		1.24 (1.17–1.32)[b]		1.12 (0.92–1.37)	
	1.13 (1.01–1.26)[c]		1.13 (1.01–1.28)[c]		1.19 (1.12–1.27)[b]		1.08 (0.88–1.33)	
≥37	6,598 (93.5)	89,110 (94.8)	4,463 (90.1)	23,269 (91.9)	18,025 (92.1)	175,223 (93.6)	1,388 (90.0)	10,026 (91.4)
	Reference		Reference		Reference		Reference	

Abbreviations: CI, confidence interval; OR, odds ratio.
[a]Adjusted by age at delivery, neighborhood poverty, neighborhood <high school completion, nulliparity, Medi-Cal coverage for delivery, hypertension, anemia, and diabetes.
[b]$p < 0.0001$.
[c]$p < 0.05$.
[d]$p < 0.01$.

Table 4 Unadjusted OR and 95% CI of a preterm delivery among mothers born preterm (<37 weeks) by mother's race/ethnicity

Sociodemographic and clinical characteristics by gestational weeks of mother birth	Mother's race/ethnicity							
	White		Black		Hispanic		Asian	
	No. (%) of infants born preterm	OR (95% CI)	No. (%) of infants born preterm	OR (95% CI)	No. (%) of infants born preterm	OR (95% CI)	No. (%) of infants born preterm	OR (95% CI)
Sociodemographic characteristics								
Age <18 years at delivery								
Mother only or grandmother only	35 (5.7)	0.85 (0.60–1.22)	103 (10.5)	1.10 (0.87–1.38)	373 (9.2)	1.24 (1.09–1.40)[a]	27 (12.7)	1.38 (0.89–2.15)
Both	1 (4.3)	[b]	9 (12.2)	1.30 (0.64–2.62)	32 (10.0)	1.37 (0.94–1.98)	2 (14.3)	[b]
Neither	426 (6.6)	Reference	376 (9.7)	Reference	1,144 (7.5)	Reference	125 (9.5)	Reference
Neighborhood poverty[c]								
Mother only or grandmother only	73 (7.7)	1.25 (0.96–1.63)	189 (10.4)	1.11 (0.89–1.38)	461 (7.7)	0.98 (0.87–1.11)	47 (10.1)	1.11 (0.76–1.62)
Both	8 (5.6)	0.89 (0.43–1.83)	117 (9.5)	1.01 (0.78–1.29)	319 (8.0)	1.02 (0.89–1.17)	19 (13.9)	1.59 (0.93–2.73)
Neither	347 (6.3)	Reference	163 (9.5)	Reference	686 (7.9)	Reference	79 (9.2)	Reference
Neighborhood <high school completion[d]								
Mother only or grandmother only	32 (6.4)	0.99 (0.68–1.44)	136 (10.4)	1.08 (0.87–1.34)	436 (7.5)	0.95 (0.84–1.08)	31 (11.6)	1.25 (0.82–1.91)
Both	5 (6.9)	1.07 (0.43–2.68)	43 (9.0)	0.91 (0.65–1.28)	248 (8.6)	1.10 (0.95–1.28)	7 (13.2)	1.45 (0.64–3.29)
Neither	390 (6.5)	Reference	290 (9.8)	Reference	774 (7.9)	Reference	108 (9.5)	Reference
Medi-Cal coverage for infant delivery								
Yes	201 (6.7)	1.04 (0.86–1.26)	322 (9.9)	1.04 (0.85–1.26)	1,070 (8.2)	1.11 (1.00–1.25)	96 (10.4)	1.12 (0.79–1.58)
No	259 (6.4)	Reference	162 (9.6)	Reference	474 (7.4)	Reference	57 (9.4)	Reference
Clinical characteristics								
Nulliparity								
Mother only or grandmother only	227 (6.2)	0.91 (0.72–1.15)	263 (9.7)	0.95 (0.76–1.19)	846 (8.2)	1.16 (1.03–1.32)[a]	82 (10.2)	1.21 (0.82–1.80)
Both	119 (7.1)	1.07 (0.82–1.39)	91 (9.6)	0.94 (0.71–1.25)	289 (8.2)	1.16 (0.99–1.35)	32 (12.2)	1.49 (0.91–2.43)
Neither	113 (6.7)	Reference	129 (10.1)	Reference	409 (7.2)	Reference	40 (8.5)	Reference
Hypertension								
Mother only or grandmother only	79 (11.7)	2.11 (1.63–2.72)[e]	85 (15.3)	1.79 (1.39–2.31)[e]	241 (15.6)	2.36 (2.03–2.73)[e]	17 (18.7)	2.18 (1.25–3.80)[a]

(*Continued*)

Table 4 (*Continued*)

Sociodemographic and clinical characteristics by gestational weeks of mother birth	Mother's race/ethnicity							
	White		Black		Hispanic		Asian	
	No. (%) of infants born preterm	OR (95% CI)	No. (%) of infants born preterm	OR (95% CI)	No. (%) of infants born preterm	OR (95% CI)	No. (%) of infants born preterm	OR (95% CI)
Both	4 (28.6)	[b]	1 (11.1)	[b]	2 (7.1)	[b]	0 (0.0)	[b]
Neither	377 (5.9)	Reference	400 (9.1)	Reference	1,305 (7.3)	Reference	137 (9.5)	Reference
Anemia								
Mother only or grandmother only	41 (8.1)	1.29 (0.92–1.80)	66 (9.3)	0.93 (0.71–1.22)	139 (7.8)	0.98 (0.82–1.17)	19 (12.2)	1.27 (0.76–2.12)
Both	1 (11.1)	[b]	1 (10.0)	[b]	0 (0.0)	[b]	0 (0.0)	[b]
Neither	418 (6.4)	Reference	419 (9.9)	Reference	1,409 (7.9)	Reference	135 (9.8)	Reference
Diabetes								
Mother only or grandmother only	30 (11.1)	1.84 (1.24–2.72)[a]	9 (6.0)	0.58 (0.29–1.14)	79 (10.2)	1.34 (1.05–1.70)[f]	12 (16.0)	1.76 (0.93–3.34)
Both	0 (0.0)	[b]	0 (0.0)	[b]	2 (33.3)	[b]	0 (0.0)	[b]
Neither	430 (6.4)	Reference	477 (10.0)	Reference	1,467 (7.8)	Reference	142 (9.8)	Reference

Abbreviations: CI, confidence interval; OR, odds ratio.
[a] $p < 0.01$.
[b] Not calculated due to $N < 5$.
[c] Zip code with ≥50% of population< 200% poverty level.
[d] Zip code with ≥50% of adults age >25 years with< high school degree.
[e] $p < 0.0001$.
[f] $p < 0.05$.

Table 5 AOR[a] and 95% CI of a preterm delivery among mothers born preterm (<37 weeks) by mother's race/ethnicity

Sociodemographic and clinical characteristics by gestational weeks of mother birth	AOR (95% CI) by mother's race/ethnicity			
	White	Black	Hispanic	Asian
Sociodemographic characteristics				
Age <18 years at delivery				
Mother only or grandmother only	0.85 (0.58–1.25)	1.10 (0.86–1.41)	1.16 (1.02–1.33)[b]	1.24 (0.77–2.01)
Both	[c]	1.35 (0.62–2.91)	1.30 (0.86–1.96)	[c]
Neighborhood poverty (zip code with ≥50% of population< 200% poverty level)				
Mother only or grandmother only	1.23 (0.92–1.66)	1.01 (0.79–1.30)	0.98 (0.85–1.13)	1.02 (0.67–1.55)
Both	0.97 (0.43–2.20)	0.95 (0.68–1.32)	0.97 (0.79–1.17)	1.30 (0.70–2.42)
Neighborhood <high school completion (zip code with ≥50% of adults age >25 years with< high school degree)				
Mother only or grandmother only	0.91 (0.60–1.37)	1.09 (0.85–1.41)	0.97 (0.84–1.11)	1.24 (0.78–1.97)
Both	1.04 (0.37–3.28)	0.96 (0.63–1.47)	1.11 (0.90–1.37)	1.16 (0.47–2.89)
Medi-Cal coverage for infant delivery				
Yes	1.02 (0.83–1.25)	1.04 (0.84–1.28)	1.12 (0.99–1.25)	1.16 (0.79–1.70)
Clinical characteristics				
Nulliparity				
Mother only or grandmother only	0.93 (0.73–1.19)	0.86 (0.68–1.09)	1.09 (0.96–1.25)	1.16 (0.76–1.77)
Both	1.07 (0.81–1.43)	0.86 (0.68–1.09)	1.05 (0.88–1.25)	1.37 (0.80–2.36)
Hypertension				
Mother only or grandmother only	2.00 (1.52–2.63)[d]	1.79 (1.37–2.34)[d]	2.39 (2.05–2.79)[d]	2.17 (1.20–3.91)[b]
Both	[c]	[c]	[c]	[c]
Anemia				
Mother only or grandmother only	1.23 (0.86–1.75)	0.93 (0.70–1.23)	0.92 (0.76–1.11)	1.25 (0.73–2.16)
Both	[c]	[c]	[c]	[c]
Diabetes				
Mother only or grandmother only	1.70 (1.13–2.56)[b]	0.57 (0.29–1.13)	1.27 (0.99–1.64)	1.66 (0.84–3.27)
Both	[c]	[c]	[c]	[c]

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval.
[a]Adjusted by other variables listed in the table using multiple logistic regression analyses, sociodemographic, and clinical characteristics in neither pregnancy was the reference except for Medi-Cal coverage for infant delivery with not Medicaid coverage as the referent.
[b]$p < 0.05$.
[c]Not calculated due to $N < 5$.
[d]$p < 0.0001$.
[e]$p < 0.01$.

despite this limitation, there were statistically significant findings in these regression models. Finally, our data spanned across three generations which may not accurately reflect, migration status, economic shifts, changes in medical practice, definitions, and terminologies.

Our findings are unique in that we describe a cross-generational risk of PTB that was consistent across maternal race/ethnicity. These findings highlight the importance of the intergeneration preterm risk, regardless of the baseline preterm risk of the mother by other characteristics. Inclusion of data on mother's gestational age at birth as well as maternal race/ethnicity, along with other well-known risk factors such as hypertension and smoking, may help identify target populations (e.g., black women born preterm) for greater focus, follow-up, and ideally, intervention.

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Conflict of Interest
None.

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